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(54) Title: LIPOSOMES FOR DEPOSITION ON HAIR

(57) Abstract

Process for the deposition, of an active ingredient on the hair by cationic liposomes, and post-wash conditioner or hair treatment masque compositions containing cationic liposomes and an active ingredient.

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LIPOSOMES FOR DEPOSITION ON HAIR

FIELD OF THE INVENTION

This invention concerns processes and compositions for the treatment of human hair. More particularly the invention concerns an improved system for the deposition of active ingredients on hair from hair treatment compositions.

BACKGROUND OF THE INVENTION AND PRIOR ART

When treating hair with rinse-off products incorporating surfactant soluble active ingredients, a considerable amount of the active ingredient will be rinsed away. Studies have shown that the level of retention in the case of a simple shampoo composition, where the active ingredient is solubilised in the surfactant micelles in the product, can be as low as 5%. Retention of these active ingredients from conditioning compositions is generally higher, probably because there is poorer solubilisation of the active ingredient in the conditioning base, but there is considerable scope for improvement, as this would provide better performance of the active ingredient and the option of reducing the level of expensive active ingredient in the product, with consequent cost saving.

It is an object of the present invention to provide an improved system for the deposition of active ingredients on hair.

BRIEF SUMMARY OF THE INVENTION

We have now found that cationic liposomes, ie. aqueous compartments enclosed by one or more lipid bilayers, can be formed which are storage-stable and possess an affinity for hair. When included in a hair treatment composition, these

liposomes deposit on the hair, are not eliminated during rinsing and can enhance the deposition on the hair of active ingredients with which they are combined.

Accordingly, in a first aspect, the present invention provides a process for the deposition of an active ingredient on hair by cationic liposomes.

In a second aspect, the present invention provides a composition comprising cationic liposomes and an active ingredient, which when applied to hair will cause enhanced deposition of the active ingredient on the hair than previously achievable.

DETAILED DESCRIPTION OF THE INVENTION

A preferred process according to the invention comprises the following steps:

(a) forming a dispersion of cationic liposomes incorporating the active ingredient,

(b) processing the dispersion into a hair treatment composition, and

(c) treating the hair with the composition.

We have found that the dispersion of step(a) may be prepared by the simple addition of solid cholesterol , along with the active ingredient, to an aqueous solution of cationic surfactant. This induces the formation of liposomes, and the structures so generated may be easily visualised using conventional contrast microscopy techniques.

The concentration of cationic surfactant in the liposomal dispersion is suitably from 2% to 10% by weight based on total weight, and the weight ratio of cholesterol to cationic surfactant is preferably 1:1.

Microscopy studies of liposomal dispersions prepared as above demonstrate at least partial encapsulation of the active ingredient in the liposomes. It is preferable to optimise such encapsulation to allow the best efficiency of deposition enhancement from the liposomal dispersions of the invention, although the exact mechanism by which this occurs is unclear. In general, it is less preferable to add the active ingredient at a later stage than addition of the liposomes, since this appears to be detrimental to encapsulation of the active ingredient by the liposomes.

However, in an alternative process according to the invention, a dispersion of cationic liposomes may be formed in situ in a hair treatment composition by the inclusion of liposomal components, typically cholesterol and cationic surfactant, during the processing stage. The active ingredient may then be incorporated into the composition after this stage.

In this alternative process, the concentration of cholesterol added during processing (by weight based on the total weight of the hair treatment composition) is suitably from 0.05 to 3%. e.g. 0.1 to 1% and the concentration of cationic surfactant added during processing is suitably from 0.15 to 5%, e.g. 0.5 to 2%, by weight based on total weight of the hair treatment composition.

Surprisingly, this also provides a favourable route to effective liposomal encapsulation of the active ingredient. It appears that in such a case, the whole of the compositional microstructure is altered so as to represent

a favourable environment for active ingredient encapsulation.

The active ingredient is normally a water-insoluble or sparingly water-soluble substance, such as an oil which may take the form of a sunscreen. Among suitable sunscreens are, camphor derivatives, benzophenone compounds such as 4,4'-tetrahydroxy-benzophenone, sold commercially as Uvinul D50, and 2-hydroxy-4-methoxybenzophenone, sold commercially as Eusolex 4360, dibenzoyl methane derivatives such as t-butyl-4-methoxydibenzoylmethane, sold commercially as Parsol 1789, and isopropyldibenzoyl methane, sold commercially as Eusolex 8020. Preferred sunscreen materials are cinnamates, such as 2-ethylhexyl-p-methoxy cinnamate, sold commercially as Parsol MCX, 2-ethoxy ethyl-p-methoxy cinnamate, sold commercially as Giv-Tan F and isoamyl-p-methoxy cinnamate, sold commercially as Neo-Heliopan E1000.

The active ingredient may also be an antidandruff agent, such as zinc pyrithione, and other 1-hydroxy pyridones. A preferred antidandruff agent is the 1-hydroxy-2-pyridone derivative known as piroctone olamine, whose chemical name is 1-hydroxy-4-methyl-6-(2,4,4-trimethylpentyl)-2-pyridone monoethanolamine salt, and which is sold under the trade name OCTIPIROX by Hoechst AG.

Other suitable active ingredients are vitamin E and derivatives thereof, volatile oils and perfumes.

The active ingredient is normally present in a concentration of from 0.005% to 5%, preferably from 0.085% to 2% by weight based on the total weight of the hair treatment composition. The optimum concentration of active ingredient will depend on the precise chemical nature of the active ingredient. For a sunscreen, if the composition comprises less than 0.005% by weight of the sunscreen,

little benefit will be obtained and if greater than 5% is present, it is unlikely that additional benefit will be obtained.

Examples of suitable cationic surfactants include: quaternary ammonium hydroxides, e.g. tetramethylammonium hydroxide, alkyltrimethylammonium hydroxides in which the alkyl group has from about 8 to 22 carbon atoms, for example octyltrimethylammonium hydroxide, dodecyltrimethylammonium hydroxide, hexadecyltrimethylammonium hydroxide, cetyltrimethylammonium hydroxide and behenyltrimethylammonium hydroxide, benzyltrimethylammonium hydroxide, octyldimethylbenzylammonium hydroxide, decyldimethylbenzylammonium hydroxide, stearyldimethylbenzylammonium hydroxide, didodecyldimethylammonium hydroxide, dioctadecyldimethylammonium hydroxide, tallow trimethylammonium hydroxide, cocotrimethylammonium hydroxide, and their corresponding salts, e.g. halides Cetylpyridinium hydroxide or its corresponding salts, e.g. halide.

Preferred cationic surfactants are cetyl trimethylammonium chloride and cetyltrimethylammonium bromide, hereinafter referred to as C.T.A.C. and C.T.A.B. respectively.

Compositions according to the present invention may further comprise one or more optional ingredients which are normally found in hair treatment compositions. The compositions of the invention will preferably take the form of post-wash hair conditioning compositions or hair treatment masques, but may also take the form of conditioning shampoos or hair styling compositions or the like.

One preferred optional component which may be included in the hair treatment compositions of the invention is a fatty alcohol or fatty acid, or derivative thereof, or a mixture of any of these, having a chain length of from about 8 to about 28 carbon atoms, more preferably from about 12 to about 18 carbon atoms. These materials may be predominantly linear or may be branched.

Such fatty material(s) may be present in the compositions of the invention in a total amount of from about 0.001 to 20% by weight, more preferably 0.01 to 10%, even more preferably 0.01 to 5% yet more preferably 0.1 to 1%. An especially preferred amount of the fatty material, if present, is up to about 0.5% by weight, since such amounts help to render the compositions smooth textured and non-lumpy.

Where it is desired to formulate a hair treatment composition of the invention which not only has conditioning properties but also has detergent properties, i.e. a shampoo, then one or more surfactants may be included, preferably selected from nonionic, amphoteric and zwitterionic surfactants.

Nonionic surfactants suitable for use in compositions of the invention include condensation products of aliphatic (C_8-C_{18}) primary or secondary linear or branched chain alcohols or phenols with alkylene oxides, usually ethylene oxide, and generally having from 6 to 30 ethylene oxide groups.

Other suitable nonionics include mono- or di-alkyl alkanolamides. Examples include coco mono- or di-ethanolamide and coco mono-isopropanolamide.

Further suitable nonionic surfactants are the alkyl polyglycosides (APG's). Typically, the APG is one which comprises an alkyl group connected (optionally via a bridging group) to a block of one or more glycosyl groups. Preferred APG's are described by the following formula:

$$RO-(G)_n$$

Wherein R is a branched or straight chain alkyl group which may be saturated or unsaturated and G is a saccharide group.

R may represent a mean alkyl chain length of from about C_5 to about C_{20}. Preferably, R represents a mean alkyl chain length of from about C_8 to about C_{12}. Most preferably the value of R lies between about 9.5 and about 10.5. G may be selected from C_5 or C_6 monosaccharide residues or mixtures of C_5 and C_6 monosaccharide residues, and is preferably a glucoside. G may be selected from the group comprising glucose, xylose, lactose, fructose, mannose and derivatives thereof. Preferably G is glucose.

The degree of polymerisation, n, may have a value of from about 1 to about 10 or more. Preferably, the value of n lies in the range of from about 1.1 to about 2. Most preferably the value of n lies in the range of from about 1.3 to about 1.5.

Suitable alkyl polyglycosides for use in the invention are commercially available and include for example those materials identified as: Oramix NS10 ex Seppic; and APG225, APG300, APG350, APG550 and APG600 ex Henkel.

Amphoteric and zwitterionic surfactants suitable for use in compositions of the invention may include alkyl amine oxides, alkyl betaines, alkyl amidopropyl betaines, alkyl sulphobetaines (sultaines), alkyl glycinates, alkyl carboxyglycinates, alkyl amphopropionates, alkylamphoglycinates alkyl amidopropyl hydroxysultaines, acyl taurates and acyl glutamates, wherein the alkyl and acyl groups have from 8 to 19 carbon atoms. Examples include lauryl amine oxide, cocodimethyl sulphopropyl betaine and preferably lauryl betaine, cocamidopropyl betaine and sodium cocamphopropionate.

Further surfactants which may be suitable for use in shampoos in accordance with the invention include one or more anionic surfactants instead of or in addition to any of those surfactants mentioned above.

Suitable anionic surfactants are the alkyl sulphates, alkyl ether sulphates, alkaryl sulphonates, alkanoyl isethionates, alkyl succinates, alkyl sulphosuccinates, N-alkoyl sarcosinates, alkyl phosphates, alkyl ether phosphates, alkyl ether carboxylates, and alpha-olefin sulphonates, especially their sodium, magnesium, ammonium and mono-, di- and triethanolamine salts. The alkyl and acyl groups generally contain from 8 to 18 carbon atoms and may be unsaturated. The alkyl ether sulphates, alkyl ether phosphates and alkyl ether carboxylates may contain from one to 10 ethylene oxide or propylene oxide units per molecule, and preferably contain 2 to 3 ethylene oxide units per molecule.

Examples of suitable anionic surfactants include sodium oleyl succinate, ammonium lauryl sulphosuccinate, ammonium lauryl sulphate, sodium dodecylbenzene sulphonate, triethanolamine dodecylbenzene sulphonate, sodium cocoyl isethionate, sodium lauroyl isethionate and sodium N-lauryl

sarcosinate. The most preferred anionic surfactants are sodium lauryl sulphate, triethanolamine lauryl sulphate, triethanolamine monolauryl phosphate, sodium lauryl ether sulphate 1EO, 2EO and 3EO, ammonium lauryl sulphate and ammonium lauryl ether sulphate 1EO, 2EO and 3EO.

The surfactant(s) may be present in the hair treatment composition in a total amount of from about 1 to 70% by weight, preferably from 2 to 40% by weight, more preferably from 5 to 30% by weight.

As further optional components for inclusion in the compositions of the invention, in addition to water, the following may be mentioned: pH adjusting agents, viscosity modifiers, pearlescers, opacifiers, suspending agents, preservatives, colouring agents, dyes, proteins, herb and plant extracts, polyols and other moisturising and/or conditioning agents.

Embodiments of the present invention will now be further illustrated by reference to the following examples. All amounts given are in % by weight, unless otherwise stated.

EXAMPLES:

Materials

Cholesterol was 95%, as supplied by Aldrich Chemical Co. CTAB was 99%, as supplied by Fluka AG. CTAC was obtained as a 50% solution (Arquad 16-50, obtained from AKZO). Octipirox and Parsol MCX were obtained from Hoescht and Givaudan-Roure respectively.

Methods

Liposome Preparation

CTAC was added to water at room temperature. Solid cholesterol was added, along with either Octipirox or Parsol MCX. The mixture was dispersed for three minutes with high shear at room temperature using a Silverson mixer. Liposome preparations were always 1:1 CTAC: Cholesterol by weight, and were between 2 and 10% CTAC.

Examples 1 to 3

Investigation of the affinity of liposomes for hair

A liposome solution was prepared as above using the following ingredients:

Cholesterol 0.125% (estimated total liposome concentration: 0.25%)
CTAC 0.125%
Demineralized water

Procedure

Hair switches of the same quality weighing about 1g were selected, and each switch immersed separately in 15ml of the prepared liposome solution. After removal of the switch, the concentration of each solution was investigated by measuring UV absorbance at 400nm. The system was calibrated with two solutions having liposome concentration of 0.20% and 0.25%.

Results are given in Table 1:

Table 1

Example	Switch immersion time	Final concentration of the solution
1	15 minutes	0.246%
2	2 hours	0.233%
3	16 hours	0.231%

Conclusion

If all of the components in the solution are assumed to be in the form of liposomes, the results indicate that liposomes are deposited on hair, as a result of the affinity between the liposomes and the hair.

Examples 4 and 5

Parsol MCX uptake by hair was examined:

- from the liposomal dispersion alone, and from micellar CTAB solution.

Procedure

Hair switches were treated with 0.2g conditioner/g hair, and 4 x 4g switches were employed. Switches were extracted after rinsing with 100 ml of ethanol for 1 hour.

Parsol concentration in the ethanol solutions were determined using a calibration curve generated by several dilutions (in ethanol) of the initial liposome dispersion, or of Parsol MCX in ethanol. Absorbances were measured at a wavelength of 309 nm.

Table 2 displays retention results obtained from:

Comparative Example A : 4% CTAB, 0.3% Parsol MCX

Example 4 : 4% CTAB, 4% Cholesterol, 0.3% Parsol MCX.

Comparative Example B : 2% CTAB, 0.15% Parsol MCX

Example 5 : 2% CTAB, 2% Cholesterol, 0.15% Parsol MCX

In Comparative Examples A and B, the Parsol MCX was shown by microscopy to be fully solubilised in the surfactant micelles. In Examples 4 and 5, the Parsol MCX was judged from microstructural studies to have been completely incorporated into the liposomal dispersion.

Table 2

Example	Parsol Retained (ug/g Hair)	Efficiency of Parsol Retention
4	95	15.7
Comparative Example A	75	12.7
5	55	17.9
Comparative Example B	45	14.4

For each of the CTAB concentrations tested, addition of cholesterol, which induces liposomes in the system, allows a 25% increase in Parsol MCX retention.

Examples 6 to 8

Parsol MCX uptake was examined:

- from fully formulated conditioners* with 10% post-processing additions of :

Comparative Example C : 2% Parsol MCX in distilled water,
Example 6 : 7.5% CTAC, 7.5% Cholesterol, 2% Parsol MCX
Example 7 : 10% CTAC, 10% Cholesterol, 2% Parsol MCX,
and
Example 8 : 4% CTAC, 4% Cholesterol, 0.85% Parsol

* The conditioner base to which the post-processing additions were made was made up from the following ingredients:

Ingredient	%wt
CTAC	0.7%
Cetearyl alcohol	3.5%
paraffin	1%
glyceryl stearate	0.7%
butyl hydroxy toluene (BHT)	0.05%
Bronopol (2-bromo-nitropropane-1,3-diol)	0.01%
perfume	0.2%
silk amino acids	0.2%
demineralised water	83.44%

Procedure

Hair switches (1g) were treated with 1g of conditioner + post-processing additive for 3 minutes, followed by a rinse of 1 minute. Switches were then extracted for 30 seconds with 10 ml of ethanol. Ethanolic extractions from the treated hair were diluted x15 with ethanol prior to measurement of absorbance.

Retention results are displayed in Table 3.

Table 3

Example	Parsol Retained (ug/g Hair)	Efficiency of Parsol Retention (%)
Comparative Example C	800	4.1
Example 6	1,150	5.6
Example 7	1,550	7.7
Example 8	800	9.6

The results demonstrate the advantage of processing Parsol MCX into the dispersion of CTAC/Cholesterol liposomes. Choosing a higher level of CTAC and cholesterol (Example 7) clearly allows a higher level of Parsol to be retained if the final concentration is 0.2% Parsol MCX. By solubilising a lower level of Parsol MCX (0.85%, giving a final concentration of 0.085%) into 4% CTAC, 4% Cholesterol, (Example 8), a retention level equivalent to that found in the control conditioner containing 0.2% Parsol MCX (Comparative Example C) can be achieved.

Examples 9 to 10

Effect of Method of Liposome Addition on Parsol MCX Uptake.

Parsol MCX retention was studied from the following systems (using a conditioner base made up as described under Examples 6 to 8):

Comparative Example D : Conditioner with a post-addition of 0.085% Parsol MCX.

Example 9 : Conditioner with a 10% post-addition of a dispersion of 0.85% Parsol MCX, 4% Cholesterol, 4% CTAC.

Comparative Example E : Conditioner with a 10% post-addition of 4% Cholesterol, 4% CTAC, and with 0.085% Parsol MCX added separately.

Comparative Example F : Conditioner with 1.1% CTAC (extra) added in the fatty phase during processing, with 0.085% Parsol and 0.4% Cholesterol added post-processing.

Example 10 : Conditioner with 1.1% CTAC, 0.4% Cholesterol added in the fatty phase during processing, and 0.2% Parsol MCX added post-processing.

Comparative Example G : Conditioner with 1.1% CTAC added in the fatty phase during processing, and 0.2% Parsol added post-processing. (No cholesterol).

The procedure followed was equivalent to that described above for Examples 6 to 8.

Results are detailed in Table 4:

Table 4

Example	Parsol Retained (mg/g hair)	Efficiency of Parsol Retention (%)
Comparative Example D	375	4.1
Example 9	800	9.1
Comparative Example E	625	7.5
Comparative Example F	400	5.2
Example 10	1,825	9.1
Comparative Example G	1,300	6.4

The results suggest that addition of the pre-prepared liposomal components incorporating Parsol MCX after conditioner processing leads to the most effective Parsol MCX retention. However, adding a higher Parsol MCX concentration, after having processed the liposome components into the conditioner (Example 10), is also an effective route to high Parsol MCX retention. In this case, the inclusion of cholesterol at the processing stage seems to have a profound effect on the structure of the conditioner.

Example 11

Uptake of Octipirox from fully formulated conditioners

Octipirox retention was evaluated from the following conditioning formulations (the conditioner base being made up as described under Examples 6 to 8):

Comparative Example H : Conditioner with Octipirox (0.1%) added post-processing in the perfume phase.

Example 11 : Conditioner with a 10% addition of 5% CTAC, 5% Cholesterol and 1% Octipirox.

Comparative Example I : Conditioner with a 10% addition of 5% CTAC, 5% Cholesterol, and with 0.1% Octipirox added separately in the perfume phase.

Procedure

1g switches were treated with either 1g or 0.2g of conditioner + additive (1 minute application). After a 1 minute rinse, each switch was placed into a centrifuge tube and 10 ml of a solution comprising:

4% Acetic acid (12%)
2% Iron (II) sulphate solution (0.17M, acidified with HCl)
94% Methanol

was added.

After 35 minutes (+/- 30) seconds in contact with the switch, the mixture was centrifuged at 3500 rpm for 5 minutes. Octipirox content in the supematant was estimated

from absorbance measurement at 462nm, using a previously determined calibration curve.

The results are shown in Table 5:

Table 5

Treatment with 1g conditioner/g hair			Treatment with 0.2g conditioner/g hair		
Example	Parsol Returned (ug/g hair)	Efficiency of Parsol Retention (%)	Example	Parsol retained (ug/g hair)	Efficiency of Parsol Retention (%)
Comparative Example H	850	8.3	Comparative Example H	500	26.3
Example 11	1,800	17.9	Example 11	1,000	46.8
Comparative Example I	1,125	11.4	Comparative Example I	575	27.3

As was found with Parsol MCX, inclusion of the Octipirox into the liposomal dispersion offers a route to enhancement of retention of x2.

Conclusions

1) Addition of cholesterol to CTAC or CTAB solutions induces formation of coarse liposomes. The structures generated can easily be visualised using contrast microscopy techniques.

2) 1:1 CTAC : cholesterol liposomes are able to partially solubilise an active ingredient such as Parsol MCX or Octipirox.

3) When fully incorporated into a liposomal dispersion, Parsol MCX retention on hair can be increased by about 25% relative to retention from a micellar control.

4) When added as a component of a liposomal premix to a post-wash conditioner, up to 50% enhancement of the retention of both Parsol MCX and Octipirox may be achieved.

CLAIMS:

1. A process for the deposition of an active ingredient on hair characterised by applying thereto a hair treatment composition in which the active ingredient is incorporated in cationic liposomes.

2. A process according to claim 1, in which the active ingredient is water-insoluble.

3. A process according to claims 1 or 2 , in which the active ingredient is selected from the group consisting of sunscreens and anti-dandruff agents.

4. A process according to any preceding claim, comprising the following steps:

(a) forming a dispersion of cationic liposomes incorporating the active ingredient,

(b) processing the dispersion into a hair treatment composition, and

(c) treating the hair with the composition.

5. A process according to any of claims 1 to 3, comprising the following steps:

(a) forming a dispersion of cationic liposomes in situ in a hair treatment composition by inclusion of liposomal components during processing thereof,

(b) incorporating the active ingredient into the composition after processing thereof, and

(c) treating the hair with the composition.

6. A hair treatment composition characterised in that it comprises cationic liposomes and an active ingredient.

7. A composition according to claim 6 which is formulated as a post-wash conditioner or as a hair treatment masque.

8. A composition according to claim 6 or claim 7, in which the liposomes are formed from a mixture of cholesterol and cetyltrimethylammonium chloride(C.T.A.C.).

9. A composition according to claim 8 in which the weight ratio of cholesterol to C.T.A.C. is 1:1.

10. A composition according to any of claims 6 to 9 in which the active ingredient is selected from the group consisting of Parsol and Octipirox.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,92 19214 (RICHARDSON-VICKS INC.) 12 November 1992 see the whole document	1-10
X	FR,A,2 676 361 (L'OREAL) 20 November 1992 see the whole document	1-10
X	EP,A,0 373 988 (L'OREAL) 20 June 1990 see the whole document	1-10
A	WO,A,92 08685 (L'OREAL) 29 May 1992 see the whole document	1-10

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Information on patent family members

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		JP-A-	3014509	23-01-91
		JP-B-	4060569	28-09-92
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		FR-A-	2680171	12-02-93
		AT-T-	117665	15-02-95
		CA-A-	2073353	15-05-92
		DE-D-	69107056	09-03-95
		DE-T-	69107056	18-05-95
		EP-A-	0510165	28-10-92
		ES-T-	2067255	16-03-95
		US-A-	5362494	08-11-94